

7

methylcyclohexane. The converted naphthalene comprises 44% trans decalin, 7% cis decalin, and 49% tetralin.

EXAMPLES 2

In another example, the same reaction mixture comprising a 3:1 blend of toluene and naphthalene was co-fed into the acoustic reaction zone, which contained a commercially available hydrogenation catalyst. FIG. 6 shows the temperature profile of the catalyst bed throughout the course of experimentation. For the first 30 minutes on stream, no acoustic energy was applied and the temperature profile of the catalyst bed remains relatively constant at a temperature of 175° C. At a time on stream from 30 minutes through 130 minutes, acoustic energy was applied to the catalyst bed. Immediately upon turning on the acoustic energy, the bed temperature rapidly increased by ~20° C. to a temperature of ~195° C. Throughout the 100 minutes when acoustic energy is applied, the catalyst bed temperature steadily increased to a temperature of 252° C. Once the acoustic energy was turned off at a time on stream of 130 minutes the temperature of the catalyst bed steadily decreased. Based on the exothermic nature of the hydrogenation reactions occurring, the increasing temperature of the catalyst bed when acoustic energy is applied to the catalyst bed is a clear indication of hydrogenation activity at atmospheric pressure. Hydrogenation activity is believed to be absent when acoustic energy is not applied since the temperature of the catalyst bed remains constant or is reduced.

EXAMPLES 3

A complex feed mixture can be fed through the system with a composition shown in Table 2. In the instant example, the experimental conditions were kept as constant as possible with the exception of the applied acoustic energy. No acoustic energy was applied and the results are representative of the degree of hydrogenation and desulfurization achievable under the such a system. FIG. 7 shows the temperature profile for as measured at the top and the bottom of the bed. When the feed is initially introduced, there is a slight increase in temperature by ~3° C. at the top of the bed due to feed preheating at 300° C. However, the temperature at both the top and bottom of the bed remains relatively constant throughout the entire experiment. The lack of temperature rise indicates little to no hydrogenation or desulfurization of the feedstock, which is confirmed by product analysis shown in Table 3. Table 3 shows that the incoming feed and outgoing product without acoustic energy applied has the same (within error) sulfur concentration and H/C ratio of the oil.

EXAMPLE 4

Under similar conditions to Example 3, Example 4 applies acoustic energy to the catalytic bed. FIG. 8 shows the temperature rise of the top and bottom of the catalyst bed. When acoustic energy is applied, there is a rapid increase in the temperature as measured at the top and bottom of the bed, indicating significant hydrogenation activity. Hydrogenation activity for when acoustic energy is applied to the system is confirmed by both the increase in temperature (even when the heater power for the catalyst zone is turned off) and by product analysis shown in Table 3. Table 3 shows reduction in sulfur content of the product oil collected after 30 minutes and 76 minutes on stream by ~100% and 96%, respectively, when acoustic energy is applied. Correspondingly the H/C ratio of

8

the oil product is improved from 1.24 to 1.44 and 1.34 after 30 minutes and 76 minutes on stream.

TABLE 2

Feed Mixture for Examples 3 and 4 Containing 275 ppm S	
Compound	Wt % in feed
Napthalene	7.12
Phenanthrene	1.57
Anthracene	0.95
Acenaphthalene	3.15
1-methyl naphthalene	23.65
toluene	30.68
Decane	22.35
Benzene	10.40
methylbenzothiophene	0.13

TABLE 3

Summary of Examples 3 and 4				
	Example 3 (TOS 0 to 72 mins)	Example 4 (TOS 0 to 30 mins)	Example 4 (TOS 30 to 76 mins)	
CONDITIONS				
WHSV, hr-1	5.1	5.2	5.2	
H2/oil (scf/bbl)	11230	11230	11230	
Acoustic Power, W	0	650	650	
Feed Preheat Temp, ° C.	300	300	300	
Wall Temperature Set, ° C.	300	260	35	
COMPOSITIONS				
H/C Ratio	1.24	1.25	1.44	1.34
Sulfur Conc., ppmw	275	273	BDL	12
mass balance		99.56	94.94	99.54

BDL = below detection limit

While a number of embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the invention in its broader aspects. The appended claims, therefore, are intended to cover all such changes and modifications as they fall within the true spirit and scope of the invention.

We claim:

1. A method of hydroprocessing a feedstock comprising one or more hydrocarbon compounds carried in, or mixed with, a transport gas, the method comprising:
flowing the feedstock through a reaction zone in a reactor, the reaction zone having a bulk pressure less than 3 atm; applying acoustic energy through the reaction zone; and chemically reacting the hydrocarbon compounds with a hydrogen source in the presence of a catalyst, said reacting occurring in the reaction zone.
2. The method of claim 1, wherein the hydrocarbon compounds comprise solid particulates.
3. The method of claim 1, wherein the hydrocarbon compounds comprise liquid fluid.
4. The method of claim 1, wherein the hydrocarbon compounds comprise vapor.
5. The method of claim 1, wherein said applying acoustic energy further comprises inducing non-linear acoustic effects.
6. The method of claim 1, wherein the reaction zone has a bulk pressure approximately equivalent to atmospheric pressure.